Appendix H. Fish

This appendix provides background on the analysis and modeling for fisheries including special status fish species, status of threatened and endangered salmonids, and intrinsic potential and large wood delivery models.

In this appendix:

Special Status Fish Species in the Planning Area

Fish species designated as Federally-Threatened or Endangered under the Endangered Species Act within the Planning Area, and the present status of Critical habitat designation are displayed in Table 256.

Table 256. Federally Threatened or Endangered Fish Species and Critical Habitat Designation within the Planning Area.

Species	ESU	Species Status	Critical Habitat Status
Chinook Salmon	Lower Columbia River	Threatened	Critical Habitat Designated
	Upper Willamette River	Threatened	Critical Habitat Designated
Coho Salmon	Southern Oregon/ Northern California	Threatened	Critical Habitat Designated
	Lower Columbia River	Threatened	Critical Habitat Designated
	Oregon Coast	Not warranted	N/A
Chum Salmon	Lower Columbia River	Threatened	Critical Habitat Designated
Steelhead	Lower Columbia River	Threatened	Critical Habitat Designated
	Upper Willamette River	Threatened	Critical Habitat Designated
Shortnose Sucker	Klamath Basin, Oregon	Endangered	Critical Habitat Proposed
Lost River Sucker	Klamath Basin, Oregon	Endangered	Critical Habitat Proposed
Bull Trout	Columbia River & Klamath River	Threatened	Critical Habitat Not Designated on Federal lands
Oregon Chub	Willamette River Valley	Endangered	Critical Habitat not designated

Fish species designated by the Bureau of Land Management as Bureau Sensitive or Bureau Assessment species are displayed in Table 257. For a complete list of non-status fish species endemic to the Planning Area, refer to the Oregon Natural Heritage Program website at (http://oregonstate.edu/ornhic/areas.html).

Table 257. Bureau Sensitive and Bureau Assessment Fish Species Present in the Planning Area.

Species	Status*
Millicoma Dace	Bureau Sensitive
Jenny Creek Redband Trout	Bureau Sensitive
Jenny Creek Sucker	Bureau Sensitive
Umpqua Oregon Chub	Bureau Sensitive
Miller Lake Lamprey	Bureau Sensitive
Coastal Cutthroat Trout (Columbia River/Southwest Washington)	Bureau Sensitive
Oregon Coast Coho Salmon	Bureau Sensitive
Fall Chinook Salmon (Southern Oregon Coast/California Coast)	Bureau Sensitive
Chum Salmon (Pacific Coast)	Bureau Sensitive
Spring Chinook Salmon (Southern Oregon Coast/California Coast)	Bureau Assessment
Steelhead (Klamath Mountains Province, Winter Run)	Bureau Assessment
Steelhead (Klamath Mountains Province, Summer Run)	Bureau Assessment

  * **Information from BLM Special Status Species List 8/10/06.**

Status Summaries and Evolutionary Significant Units for Threatened or Endangered Salmonids

The following are summaries of the status of listed fish species within the plan area. Summaries for salmon and steelhead are from the National Marine Fisheries Service "Updated Status of Federally Listed ESU's of West Coast Salmon and Steelhead" (June 2005). The specific listing status of the species and the threats to the species, are given in the specific Federal Register notice for each species or group of species covered by the notice. The Federal Register notices can be found at the NMFS web site http://www.nwr.noaa.gov for anadromous fish and the U.S. Fish and Wildlife Service web site http://www.fws.gov/pacific/ for resident fish. Federal Register notices for rules regarding the designation of critical habitat can also be found at these web sites. The Federal register notices give the basic life history requirements for the listed species, the threats that caused the listing, and for critical habitat those basic requirements necessary for the survival and recovery of the species.

Lower Columbia River Chinook Salmon Evolutionary Significant Unit

The Willamette and Lower Columbia Technical Recovery Team estimated that 8 to10 historical populations in this ESU have been extirpated, most of them spring-run populations. Near loss of that important life history type remains an important Biological Review Team concern. High hatchery production continues to pose genetic and ecological risks to natural populations and to mask their performance. Most populations in this ESU have not seen as pronounced increases in recent years as occurred in many other geographic areas.

Figure 294. Historical independent Lower Columbia River Evolutionary Significant Unit early and late-fall-run Chinook salmon populations. Source: Myers et al. (2002).
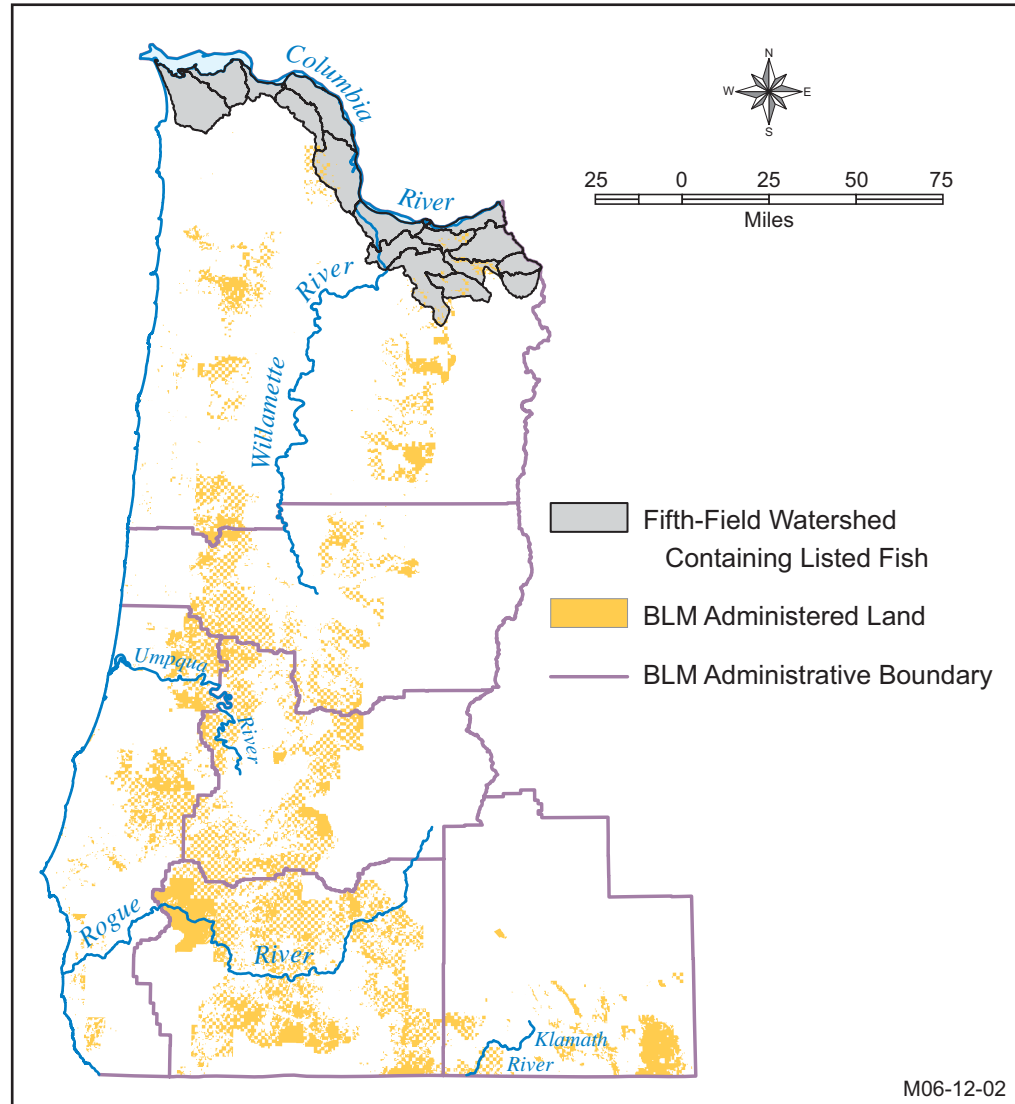
Upper Willamette River Chinook Salmon Evolutionary Significant Unit

Updated status reviews and technical reports preliminary analysis indicate that most natural-origin spring-run Chinook populations are likely extirpated, or nearly so.

Figure 295. Historical populations of spring-run Chinook salmon in the Upper Willamette River Evolutionary Significant Unit. Source: Myers et al. (2002).
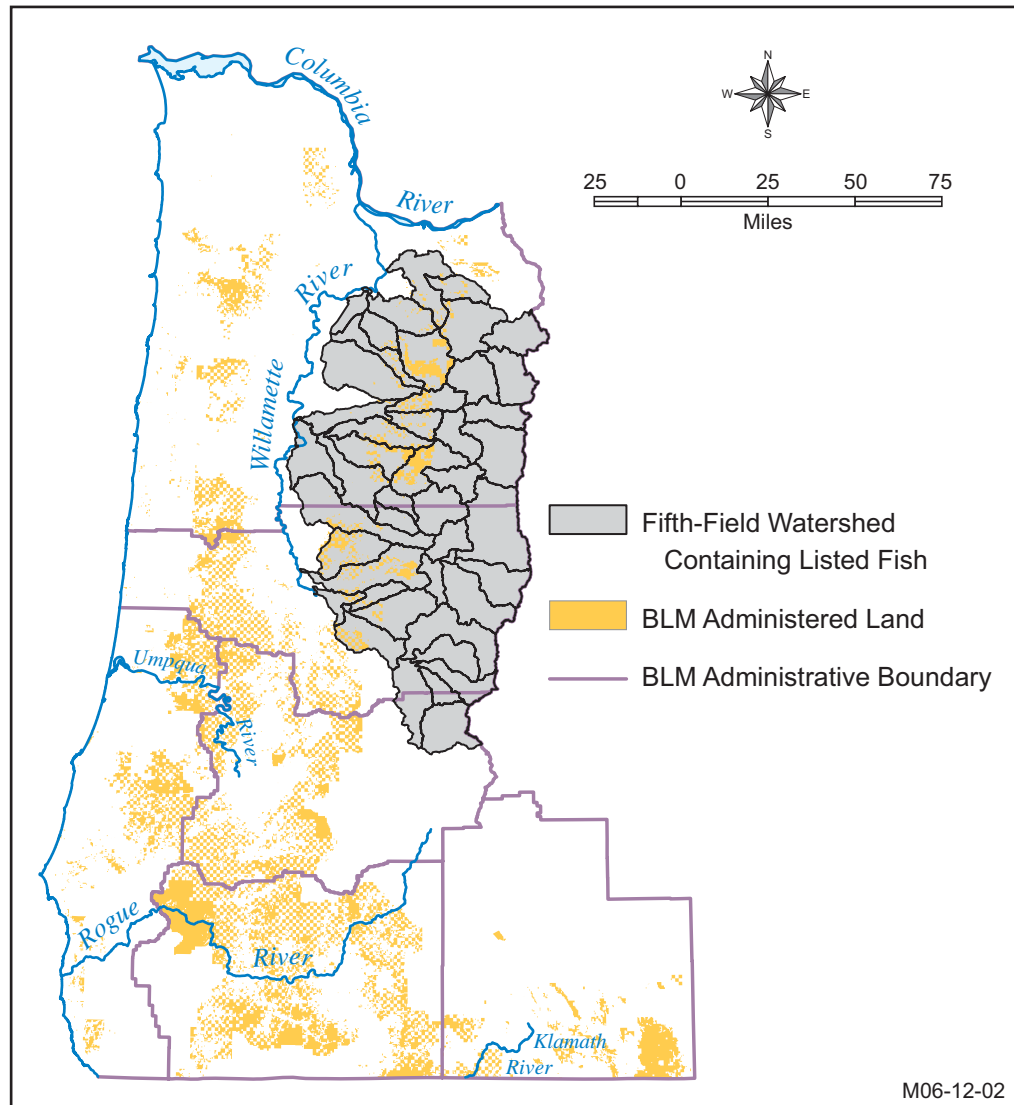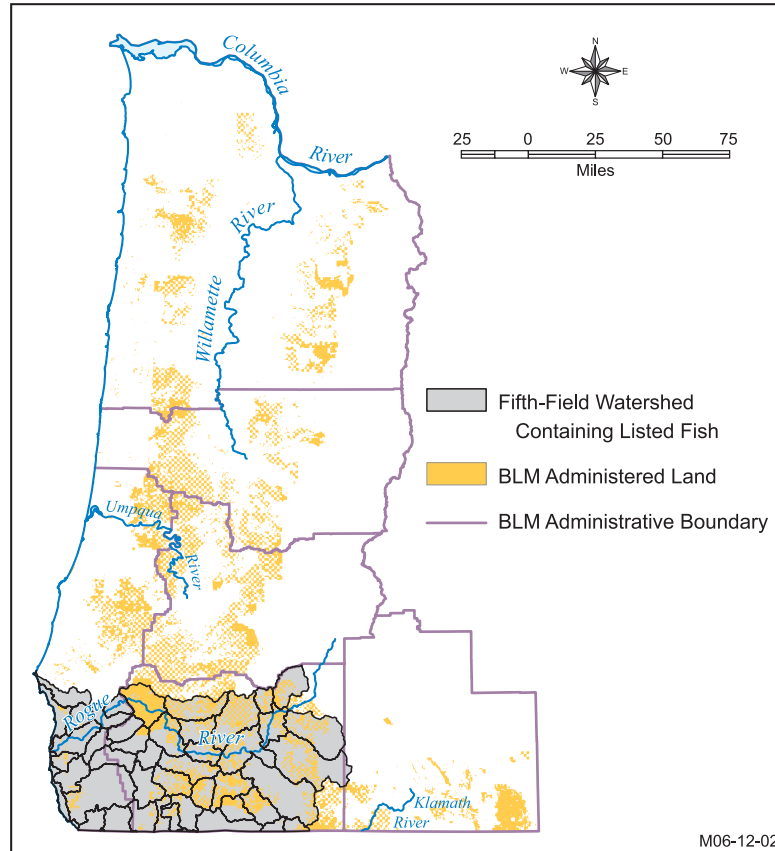
Southern Oregon/Northern California Coast Coho Salmon Evolutionary Significant Unit

Southern Oregon/Northern California Coast coho salmon Evolutionary Significant Unit exhibit low population abundance relative to historical numbers and long-term downward trends in abundance. A reliable time series of adult abundance is available only for the Rogue River. These data indicate that long-term (22-year) and short-term (10-year) trends in mean spawner abundance are trending upward in the Rogue, however, the positive trends reflect effects of reduced harvest rather than improved freshwater conditions, because trends in pre-harvest recruits are flat.

The relatively strong 2001 broodyear, likely the result of favorable conditions in both freshwater and marine environments, was viewed as a positive sign, but was a single strong year following more than a decade of generally poor years. On the positive side, extant populations can still be found in all major river basins within the Evolutionary Significant Unit, and the relatively high occupancy rate of historical streams observed in broodyear 2001 suggests that much habitat remains accessible to coho salmon.

Figure 296. Historical populations of the Southern Oregon/Northern California Coast Coho Evolutionary Significant Unit


Southern Oregon Northern California Coho

Lower Columbia River Coho Salmon Evolutionary Significant Unit

In the only two populations with significant natural production (Sandy and Clackamas rivers), short- and long-term trends are negative, and productivity is down sharply from recent (1980s) levels. On the positive side, adult returns in 2000 and 2001 were up noticeably in some areas, and evidence for limited natural production has been found in some areas outside the Sandy and Clackamas rivers.

Figure 297. Tentative historical populations of the Lower Columbia River coho salmon Evolutionary Significant Unit. Source: based on work by Willamette/Lower Columbia Technical Recovery Team for Chinook salmon and steelhead (Myers et al. 2002).
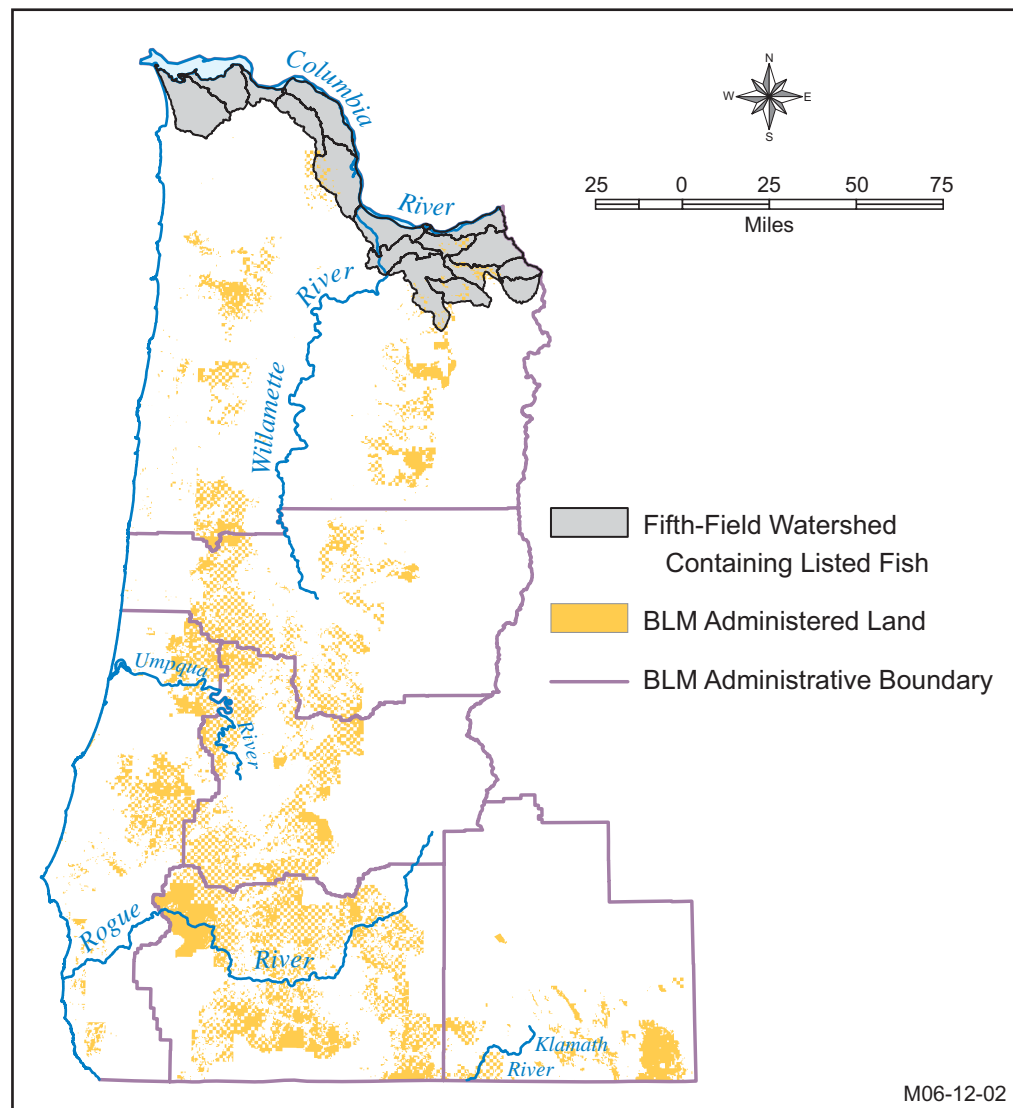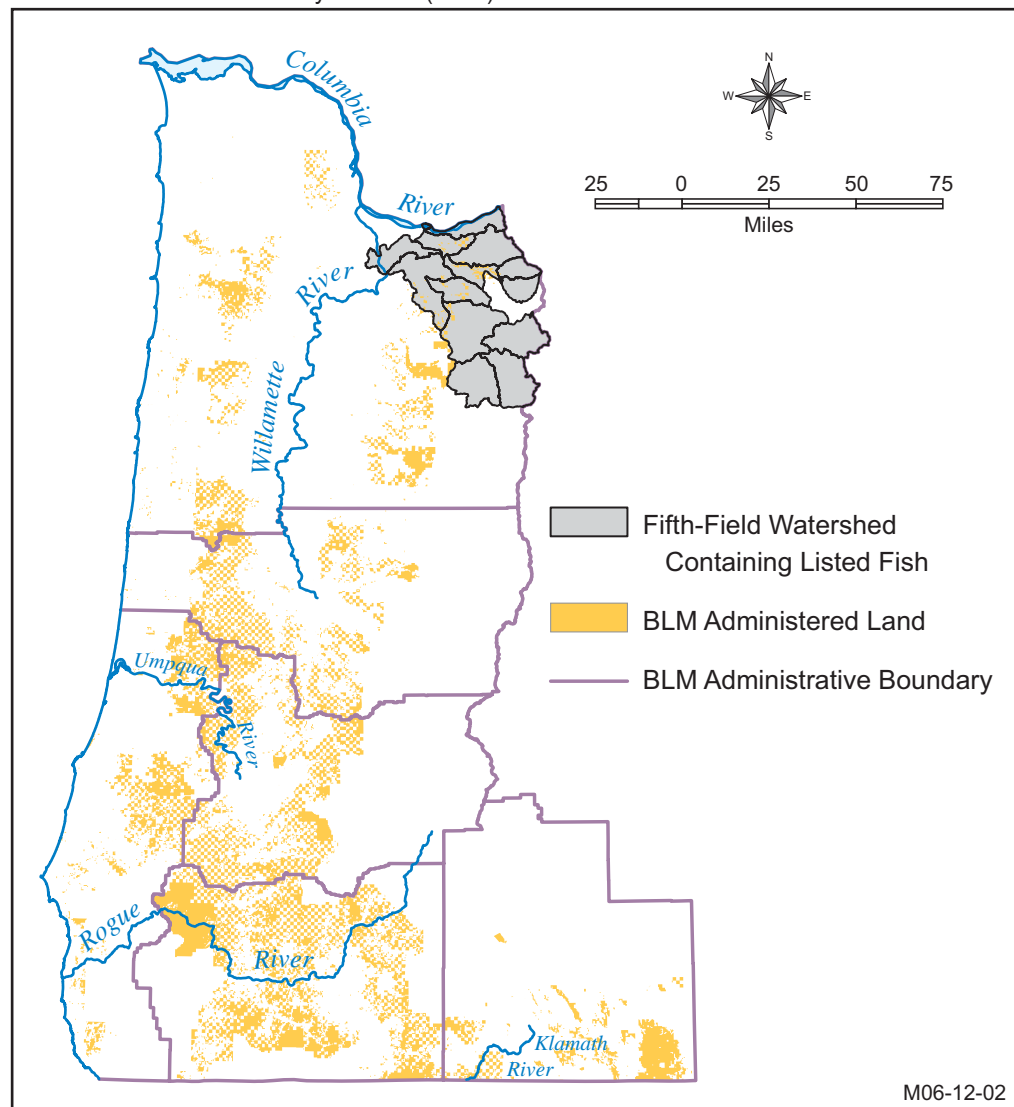
Lower Columbia River Steelhead Evolutionary Significant Unit

Abundance of most populations is relatively low, and those populations for which there is adequate modeling data are estimated to have a relatively high extinction probability. Some populations, particularly summer run, have shown higher returns in the last 2 to 3 years. The Willamette and Lower Columbia Technical Review Team (Myers et al. 2002) has estimated that at least four historical populations are now extinct.

Figure 298. Historical populations of winter-run steelhead in the Lower Columbia River steelhead ESU. Source: Myers et al. (2002).

Upper Willamette River Steelhead Evolutionary Significant Unit

After a decade in which overall abundance (Willamette Falls count) hovered around the lowest levels on record, adult returns for 2001 and 2002 were up significantly, on par with levels seen in the 1980s. Still, the total abundance is small for an entire ESU, resulting in a number of populations that are each at relatively low abundance.

Figure 299. Map of historical Upper Willamette River steelhead Evolutionary Significant Unit populations
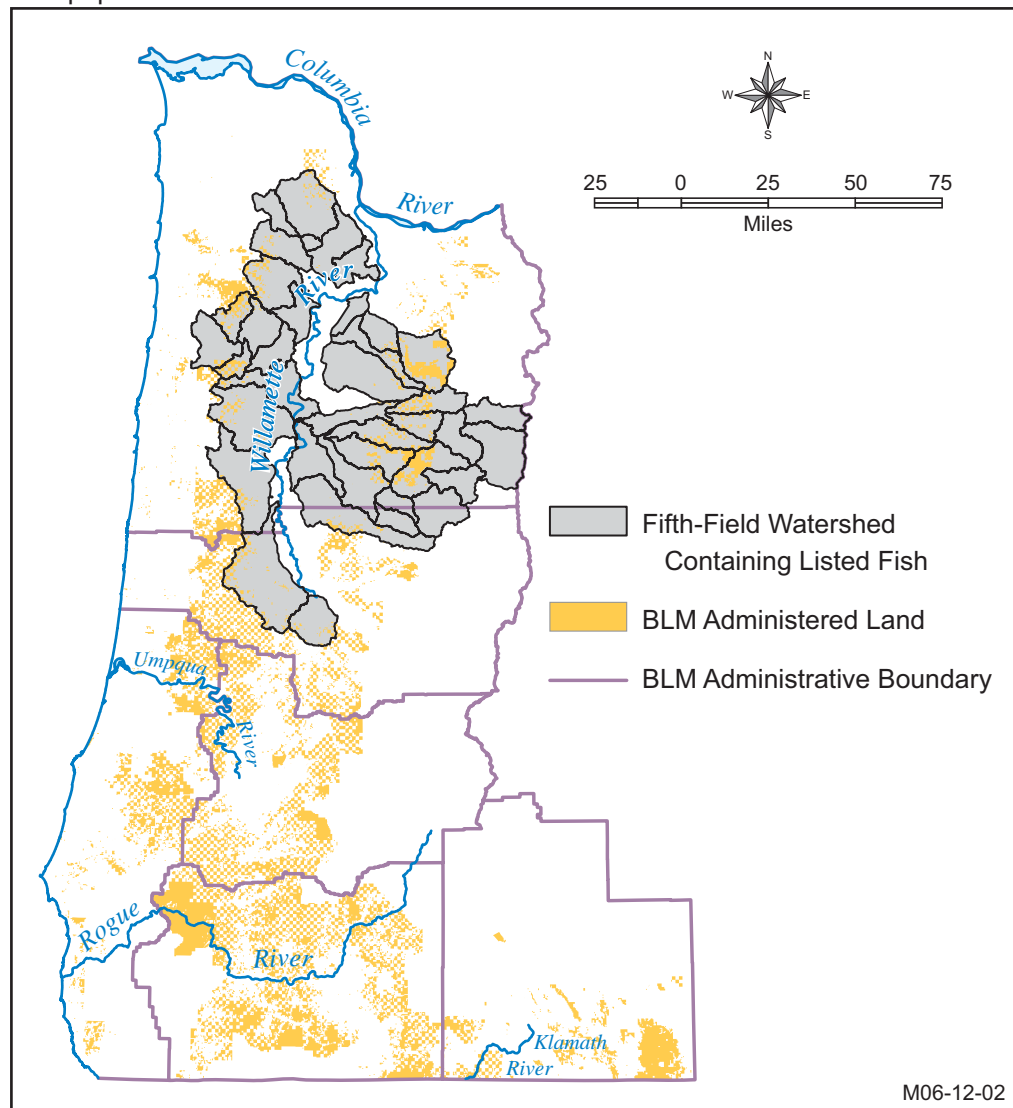
Columbia River Chum Salmon Evolutionary Significant Unit

Chum salmon spawn on the Oregon side of the lower Columbia Gorge in the Multnomah area, but appear to be essentially absent from other populations in the Oregon portion of the Columbia River chum salmon Evolutionary Significant Unit. With the exception of the lower Columbia Gorge population, Columbia River chum salmon are considered extirpated, or nearly so, in Oregon.

Figure 300. Historical chum salmon populations in the Columbia River chum salmon ESU.
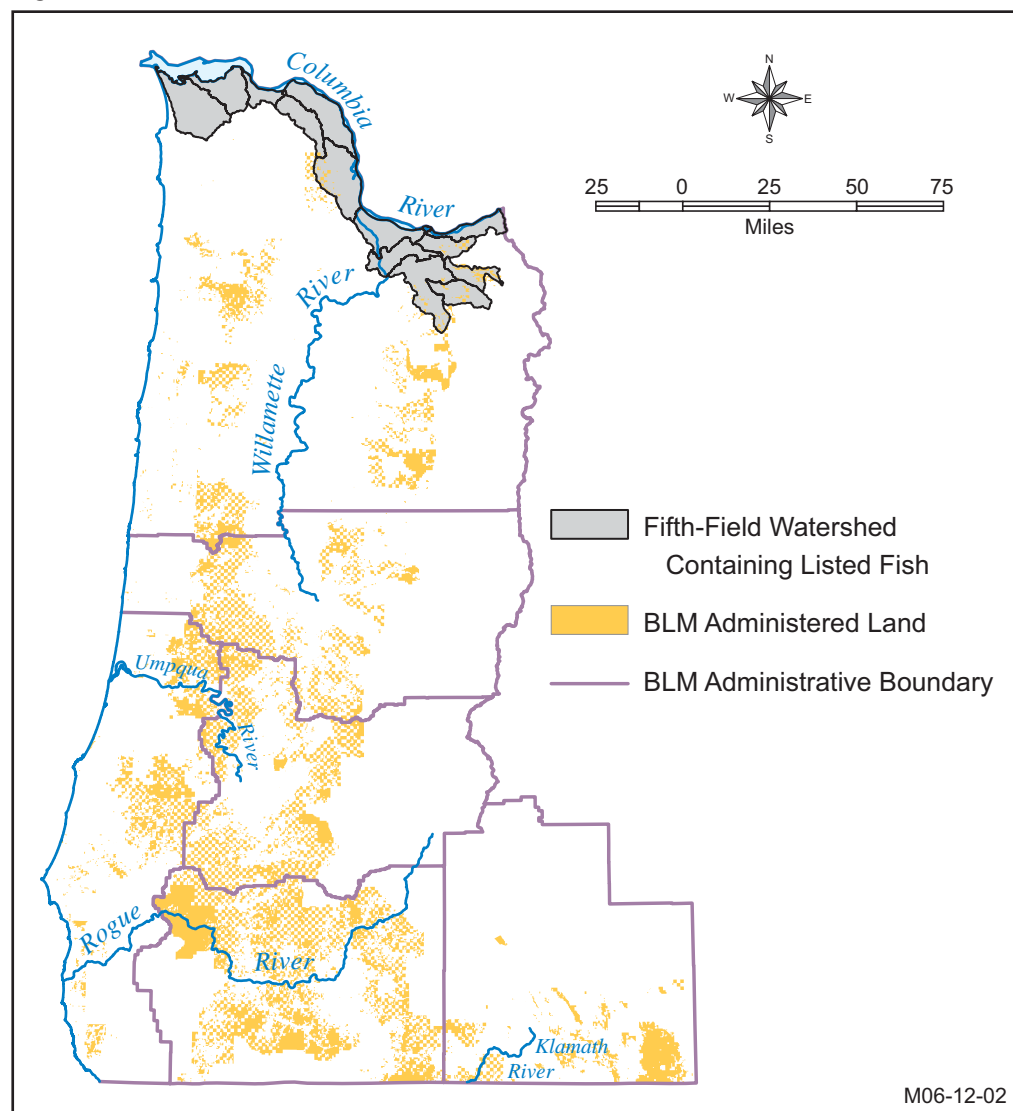
Shortnose and Lost River Suckers

The Lost River and shortnose sucker are endemic to the Upper Klamath Basin of California and Oregon. Declining population trends for both species were noted as early as the mid-1960s, but the severity of the population declines was not evident until the early 1980s. In 1988, both Lost River and shortnose suckers were listed as endangered by the U.S. Fish and Wildlife Service.

The adult sucker monitoring program (USGS) has provided valuable information on the current status of sucker populations in the Upper Klamath Basin. Monitoring indicates there has been no significant recruitment into the adult population in the last few years (USGS).

Bull Trout

Bull trout were historically found in about 60 percent of the Columbia River Basin, but now occupy less than half of their historic range. Populations remain in portions of Oregon, Washington, Idaho, Montana and Nevada. In the Klamath River Basin, bull trout occupy only 21 percent of their historic range. While bull trout exist over a large area, their distribution and abundance has declined with several local extinctions documented. Many remaining populations are small and isolated from each other, making them more susceptible to local extinctions.

Oregon Chub

Oregon chub are endemic to the Willamette River Valley of western Oregon. Although information is scarce, historically the Oregon chub probably existed throughout the lower elevations of the Willamette River valley. The current distribution is limited to approximately 20 naturally occurring populations and 4 recently reintroduced populations. The populations are found in the Santiam River, Middle Fork Willamette River, Coast Fork Willamette River, McKenzie River, and several tributaries to the Mainstem Willamette River downstream of the Coast Fork/Middle Fork confluence. Almost all of the populations are small and isolated.

Recovery Planning

Recovery Plans for Willamette/Lower Columbia River chinook, coho, chum, and steelhead are underway. The status of the plans is currently available on the NMFS web site. Recovery Plans for Lost River and Shortnose suckers are available USFWS web site. The updated status of the various populations, a discussion of the existing limiting factors and threats to the populations will be developed in the various plans.

Intrinsic Potential Model and Large Wood Delivery Model

Intrinsic Potential Model

Intrinsic potential is a scientific, topographical approach used to determine the potential of a stream to provide high-quality habitat for salmonids. Comprehensive information on the location of stream reaches with the greatest potential to provide high-quality habitat for salmonids was generally missing for the planning area. The intrinsic potential of stream channels to provide high-quality rearing habitat was modeled for juvenile coho salmon (*Oncorhynchus kisutch*), juvenile steelhead (*O. mykiss*), and juvenile chinook salmon (*O. tshawytscha*). The initial research was conducted in the Coastal Landscape Analysis and Modeling Study (CLAMS) and was expanded for coho, steelhead and chinook on all ownerships within the planning area.

Spatial models were developed that estimate the potential of streams to provide high-quality rearing habitat for coho, steelhead and chinook. The calculated metric, termed intrinsic potential, reflects species-specific associations between fish use and persistent stream attributes; stream flow, valley constraint, and stream gradient.

The intrinsic potential for each stream reach was modeled independently for juvenile steelhead, coho, and chinook salmon from stream attributes of mean annual stream flow, valley constraint, and channel gradient. These attributes were produced in conjunction with the digital stream network from 10-m digital elevation models (DIGITAL ELEVATION MODELs) (Miller 2003). The stream network output was in an ArcView shape file format and then imported into ArcInfo (version 8.3; ESRI, Redlands, California, USA) for all subsequent processing. Stream attribute values were translated into index scores for each species (Figure 301. *Relationship between values of the three stream attributes (mean annual stream flow, calibrated valley-width index, and channel gradient) and the index scores that were used to calculate intrinsic potential for steelhead, coho, and chinook salmon*).

The index scores were based on empirical evidence from published studies regarding the relationship between a stream attribute and juvenile fish use. Following the most commonly applied approaches for modeling habitat suitability (Morrison et al. 1998 and Vadas and Orth 2001 in Burnett et al *in press*), intrinsic potential for each stream reach was calculated by multiplying the un-weighted species-specific index scores together and then taking the geometric mean of the product. This approach reflects the assumption that the three stream attributes are of approximately equal importance and only partially compensatory, and that the smallest index score has the greatest influence on the intrinsic potential. The index scores and intrinsic potential can range from zero to one; larger values indicating a greater potential for providing high-quality rearing habitat. Stream reaches were classified with a high species-specific intrinsic potential when the calculated

value was 0.75. Intrinsic potential is reported for a species only below naturally occurring barriers to migrating adults. (Burnett et al, *in press*)

Figure 301. Examples of relationship between values of the three stream attributes and the index scores used to calculate intrinsic potential.
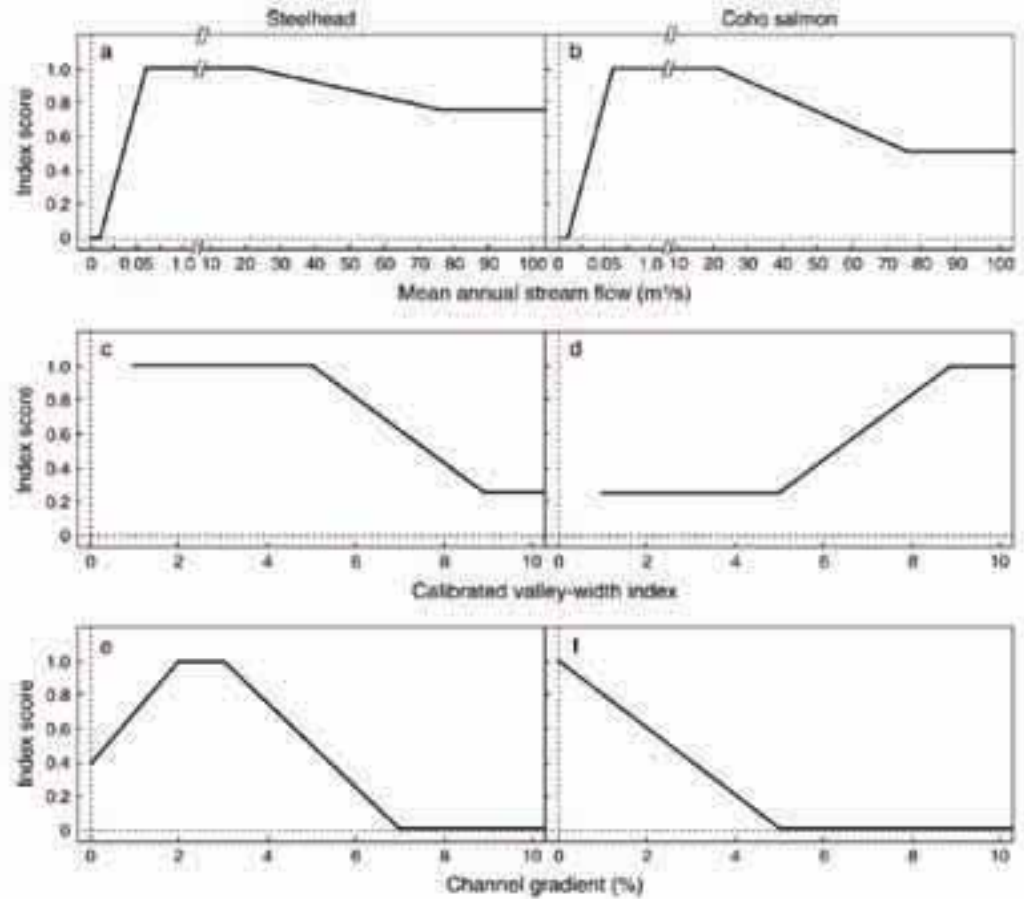
Large Wood Delivery Model

The large wood delivery model is a spatially explicit, Geographic Information System-based wood recruitment model developed for this analysis to determine the potential large wood contribution to fish bearing streams from BLM-administered lands. The model determines the large wood contribution from each recruitment source:

- Riparian tree fall

- Channel migration

- Debris flow

For the wood recruitment model, metrics were developed to compare wood input rates by recruitment process and by location. A simplified set of stand types were used: Stand Establishment, Young, and Mature and Structurally Complex. For each stand type, three size classes were specified: 0-10"dbh, 10-20" dbh, and > 20" dbh. For each size class, a single average tree height was specified. As a measure of wood input, the number of trees from the large size class (dbh > 20") from the Mature and Structurally Complex size class entering any stream was used. Inputs from smaller size classes or from the other two stand types were not included.

The distance from which falling trees could enter the channel was determined using the average tree height. To determine the input of large wood to streams the Stand Establishment and Young stand types have few or no large trees, so excluding these stand types did not affect the overall spatial and temporal patterns predicted by the models. Likewise, exclusion of the smaller size classes did not alter predicted patterns of input of large wood.

The size of the wood entering the channel is not tracked in order to simplify interpretation of model results; only trees of a particular size class, from a particular stand type, are tracked to channels. These simplifications highlight the primary spatial and temporal patterns predicted by the stand growth and wood recruitment models.

The model estimates average annual wood inputs, with no indication of temporal variability in input rates. This enables the identification of potential source areas for each recruitment processes, channel reaches potentially receiving wood from each process, and for examining spatial differences in average recruitment rates. However, the spatial pattern found for actual in-channel wood loads are very different than the pattern found for average recruitment rate: debris flow inputs, for example, occur only rarely. Hence, for any reach, the relative importance of debris flow inputs can vary dramatically over time depending on how long it has been since the last debris flow occurred. The stochastic nature of wood recruitment processes causes wood inputs to be episodic, punctuated in time a space. Patterns indicated by the wood recruitment model show where certain processes are active and how long-term average rates differ from location to location, but cannot predict how actual rates differ from year to year.

Methods

The stream channel network was traced using 10-meter Digital Elevation Models and the Western Oregon Plan Revision Geographic Information System stream fish distribution layer and Ground Transportation Road Network was used to determine fish bearing stream channels and all road and stream crossings.

Figure 302. Using Digital Elevation Models to delineate stream. For each Digital Elevation Model point, all stream-edge segments are found within one tree height.
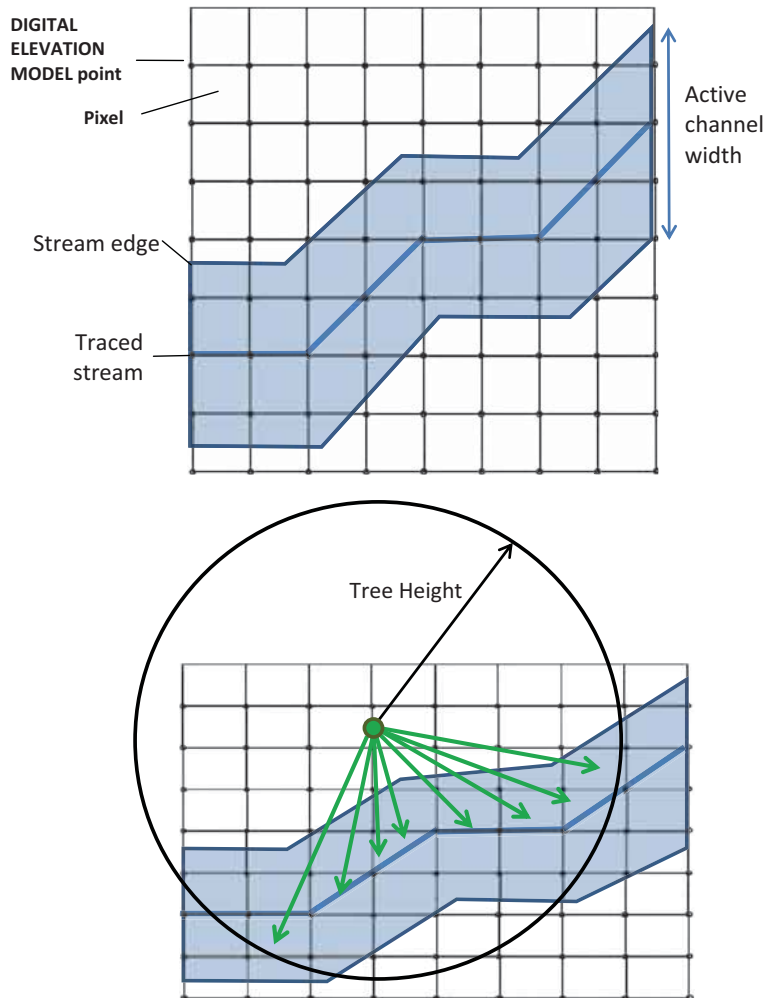
For each stream-edge segment, the probability that a tree at the Digital Elevation Model point hits the segment when it falls was determined. Input information included the following and was repeated for every Digital Elevation Model point:

- Fall direction   (closest edge segment)
- Angle subtended
- Distance to stream edge
- Slope at Digital Elevation Model point

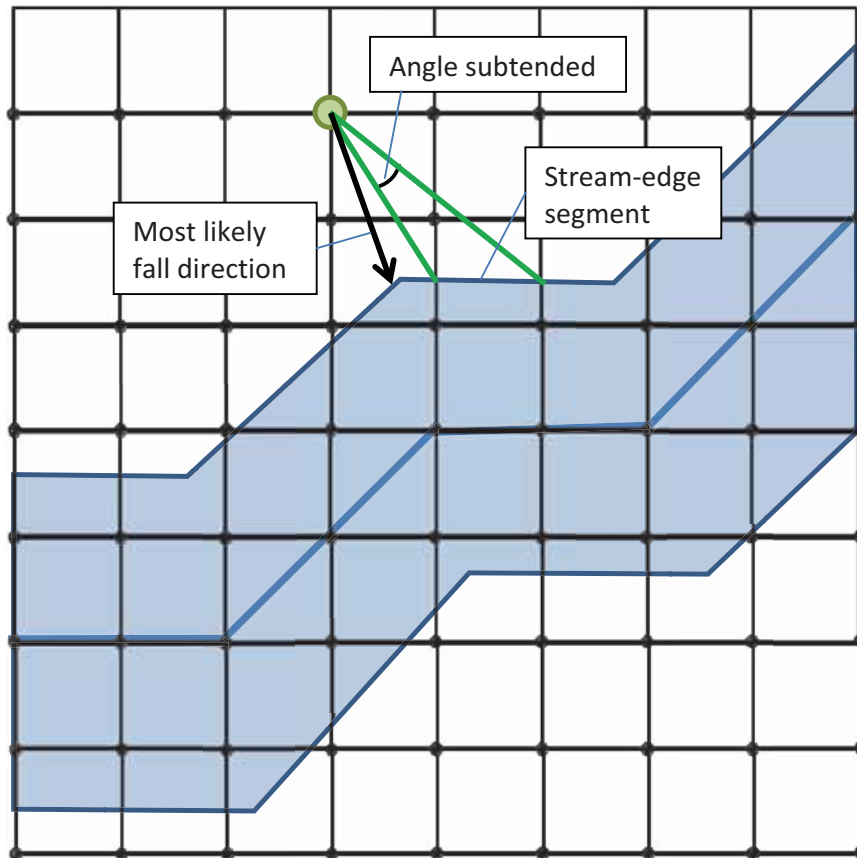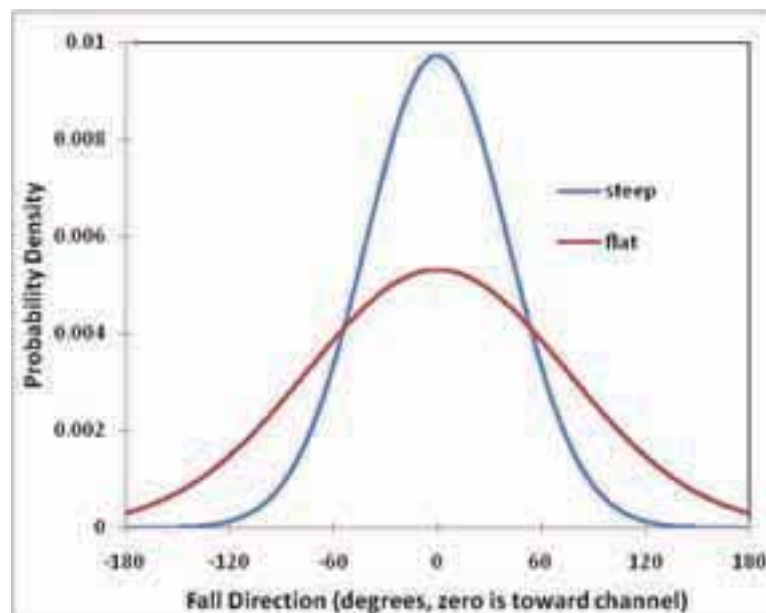Figure 303. Determining tree fall using DEMs.

Figure 304. Probability that a falling tree at a DEM point hits a stream segment.

From these inputs, the following is determined for every Digital Elevation Model point:

- A list of every stream segment potentially hit by a falling tree from that point
- For each segment, the probability that the falling tree will cross the channel edge

For each stream-edge segment, the probability that a tree at the Digital Elevation Model point hits the segment when it falls was determined. Input information included the following and was repeated for every Digital Elevation Model point:

- Fall direction   (closest edge segment)
- Angle subtended
- Distance to stream edge
- Slope at Digital Elevation Model point

From these inputs, the following is determined for every Digital Elevation Model point:

- A list of every stream segment potentially hit by a falling tree from that point
- For each segment, the probability that the falling tree will cross the channel edge

For each stream segment the following is determined:

- A list of every Digital Elevation Model point from which a falling tree might cross the segment

Each Digital Elevation Model point is associated with a 100-m2 pixel, and each pixel has an associated forest cover type (from OPTIONS growth and yield model):

- Stand Establishment
- Young
- Mature
- Structurally Complex

Each forest cover type has an associated stand table divided into tree-size classes. For each tree-size class the following is used:

- stem density,
- diameter at breast height range
- average tree height
- mortality rate

With this information, for each corner of the pixel, the probability that a tree falls and that it hits a stream-edge segment is calculated. This probability is integrated over the area of the pixel to calculate the annual probability that a tree within the pixel falls and hits a stream-edge segment and is repeated for every segment potentially hit by a falling tree from within the pixel.

Figure 305. Tree fall from riparian areas dependent on: forest cover, hillslope gradient, distance to stream channel, and channel planform geometry.

Pieces per year

High (0.005)

Low (0.0)
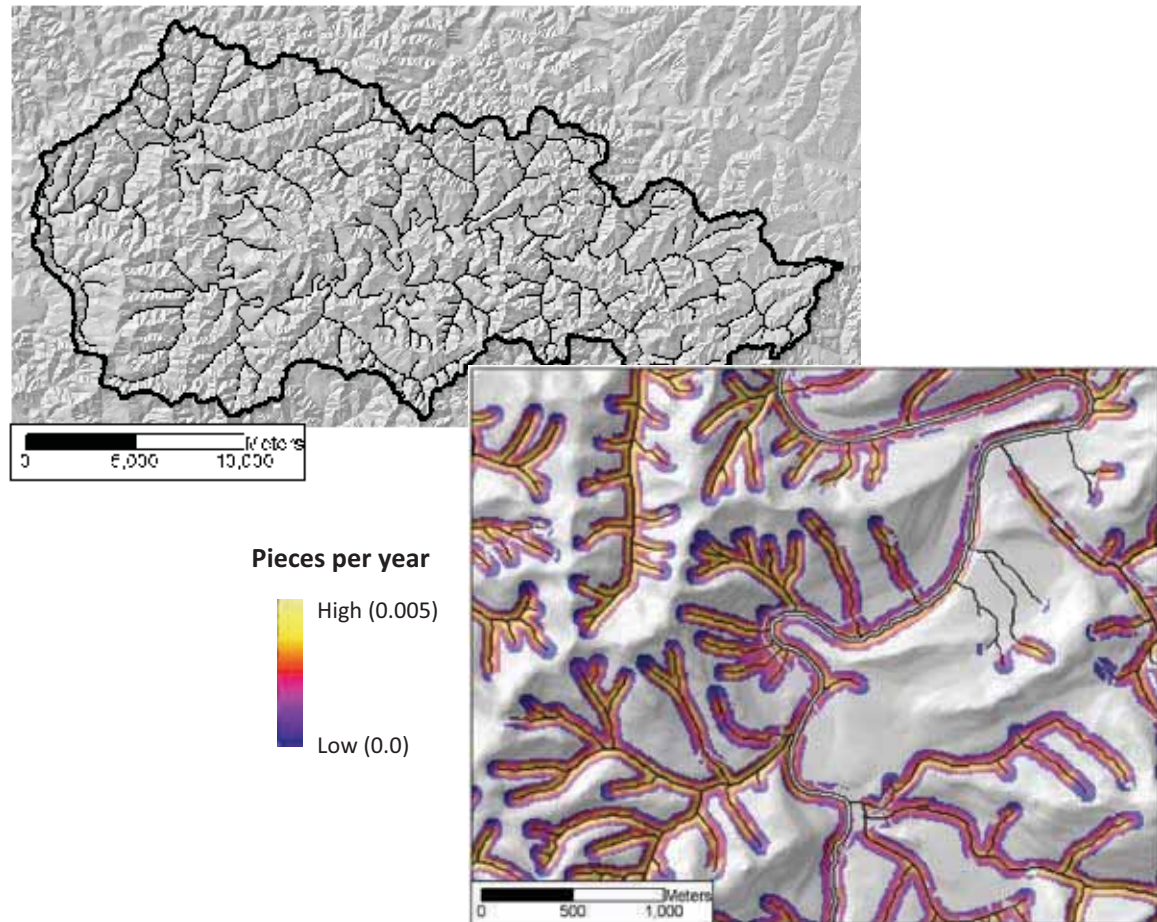
Channel Migration

To determine the large wood input from a channel migration zone the following factors were determined:

- Valley floor extent

- Valley floor composition and vegetation

To determine the channel migration zone, potential floodplain areas were delineated and a constant probability was applied of floodplain occupation (e.g. channel migration across the entire floodplain every 100 years). Wood recruitment was determined from stand tables with trees available for recruitment from each valley-floor pixel and assigning each valley-floor pixel a specified annual probability of being exhumed by the migrating channel (e.g., 0.01).

Figure 306.   Identification of valley-floor pixels: within a specified elevation of the channel; within a specified slope relative to the channel slope; all pixels flagged meeting these criteria with the identification of the reach to which they drain.
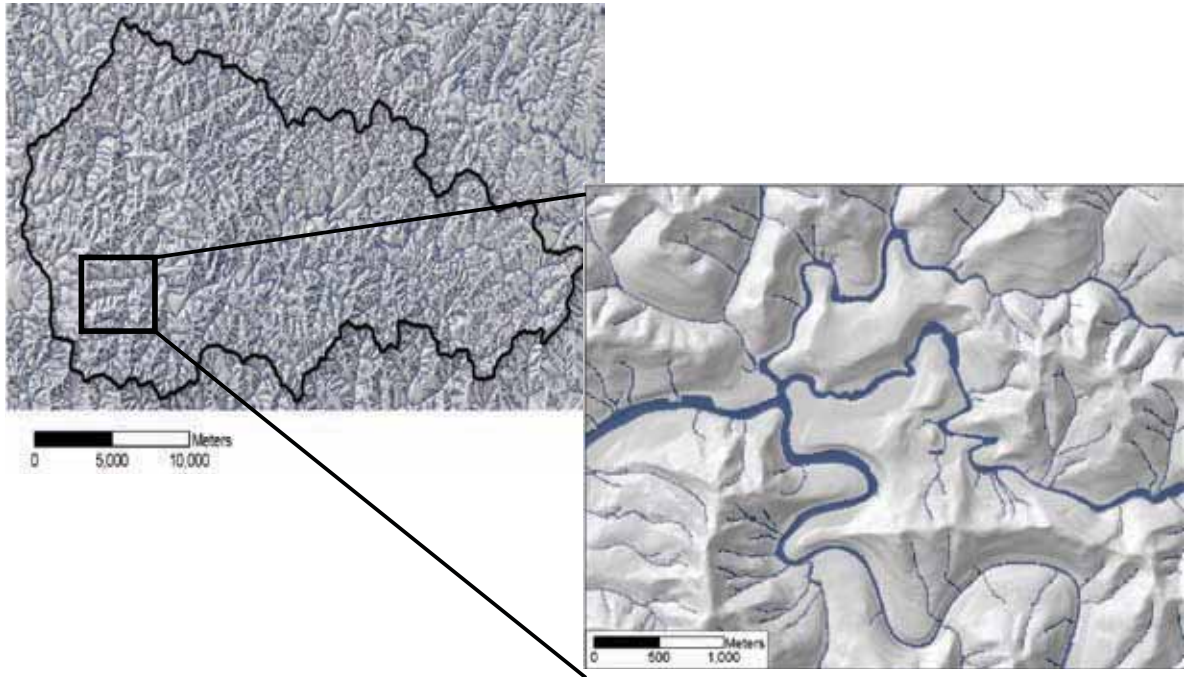
Debris Flow

The model uses topographic characteristics from 10-meter Digital Elevation Models to identify all debris-flow initiation points across the landscape (Miller and Burnett, 2007) and identify the travel path from each source pixel to a fish bearing stream channel (Burnett and Miller, 2007; Miller and Burnett, in review). The Ground Transportation Road Network Geographic Information System layer was used with the travel path to determine road stream crossings and wood routing barriers. Each conditional probability that each Digital Elevation Model pixel was traversed by a debris flow was determined. All relative probabilities were multiplies to give a specified mean recurrence interval for all 3rd and higher-order channels (350 years).

For each Digital Elevation Model pixel, a mean annual probability of being traversed by a debris flow is determined. Starting from each debris-flow source pixel, the potential wood is accumulated pixel by pixel along each debris-flow source track

The proportion of wood taken from each pixel is determined by:

- Mean debris flow track width (from Oregon Department of Forestry data)

- The probability of no debris-flow deposition in the pixel

The proportion of accumulated wood deposited in each pixel is determined by the relative downslope decrease in debris-flow traversal probability (e.g., if traversal probability decreases by 20%, 20% of the accumulated wood is deposited)

Sources for debris flow wood:

- Standing trees (from stand tables)

- Down wood (calculated as per riparian)

- Wood deposited by previous debris flows

The amount of deposited wood that gets picked up by the next debris flow is determined by the probability that the wood is still in the channel when the next debris flow comes along $(1 – (1-PDF)R)$; where PDF is annual probability of debris flow traversal and R is $(1/PDF)$, the recurrence interval. This is equal to ~0.63 for all values of PDF. The assumption is that only buried wood survives (surface wood decays) and that 30% of the wood is buried. That gives ~20% of previously deposited wood available for future debris flow scour. This amount was multiplied by the probability of scour to estimate the amount of previously deposited wood picked up by debris flows.

Figure 307.   Debris flow source areas for wood are widely distributed, but most of the wood accumulated by debris flows is scoured from low-order channels.
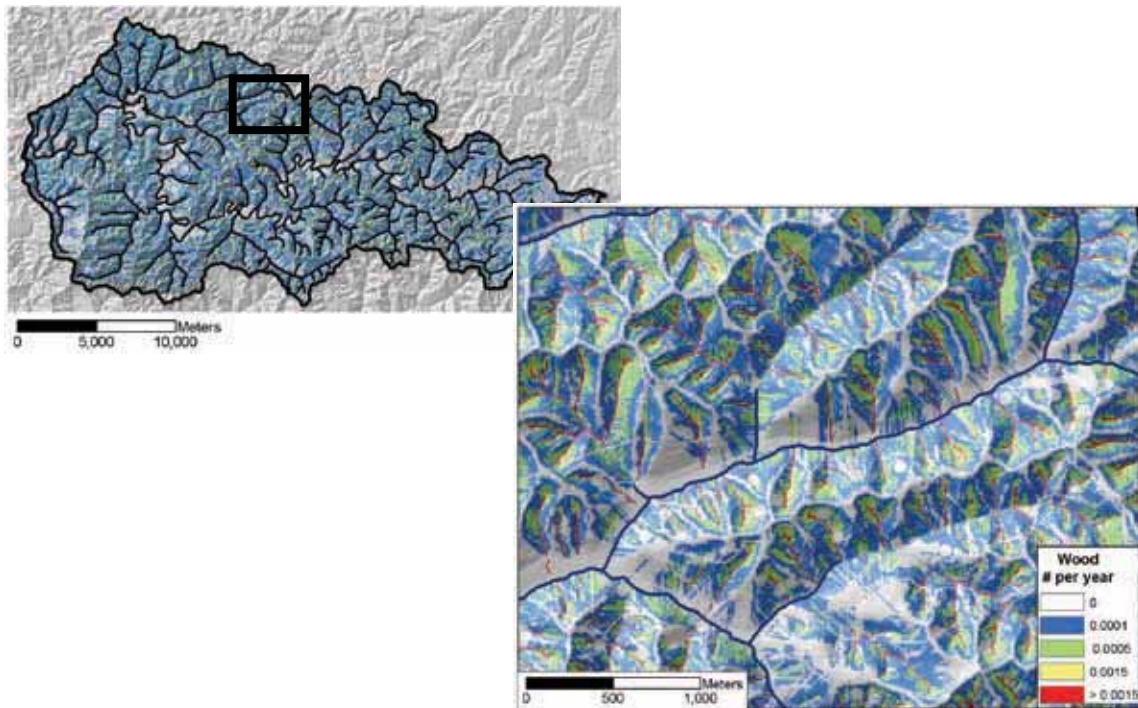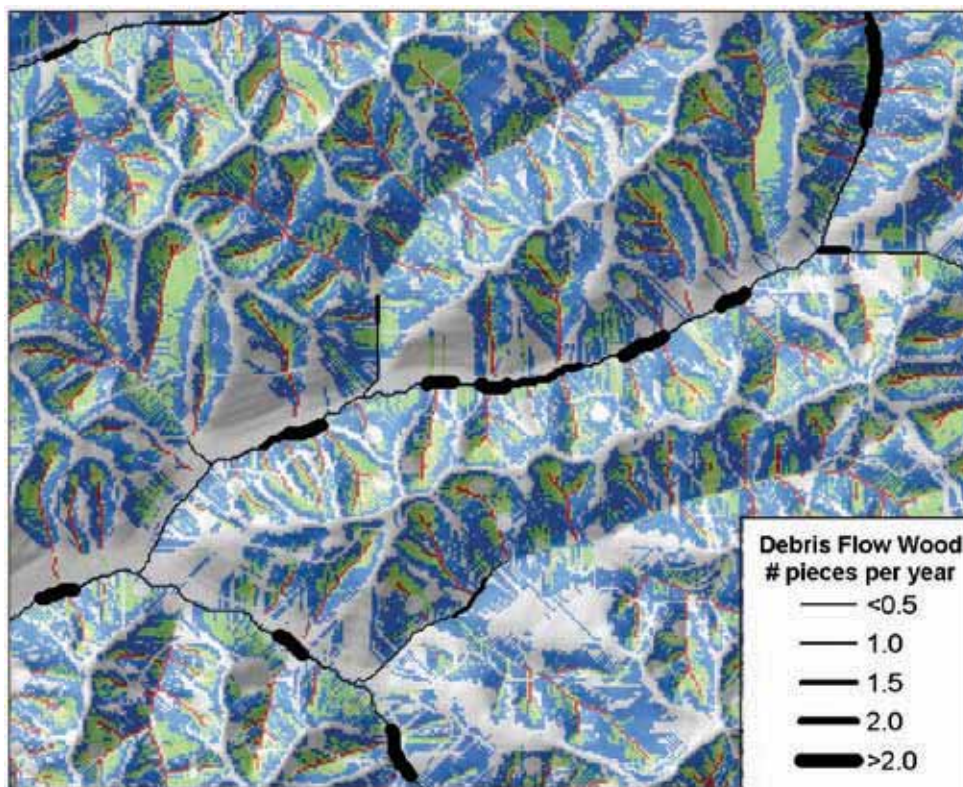
Figure 308.   Debris flow inputs to fish-bearing streams occur at these low-order channel junctions.

Fish Productivity Index

A fish productivity index was developed for assessing the effects of wood recruitment on fish habitat. The index is used to assess potential fish habitat within a basin. The index is based on the assumption that available habitat is proportional to available channel area; (e.g., large channels can support more fish than small channels). Channel surface area is estimated as the product of channel width and channel length, determined from channel courses traced from a 10-m Digital Elevation Model. The available channel area is then modified using a species-specific measure of intrinsic habitat potential (Burnett et al. in press): an index that varies between zero and one as a function of channel gradient, mean annual flow, channel width, and valley width. (Both mean annual flow and channel width are calibrated functions of drainage area and mean annual precipitation, (Clarke et al. in review)).

A similar approach was used by Lawson et al. (Lawson et al. 2004) to estimate channel area available for coho production for basins in western Oregon. Summed over all channels in a basin, this index provides a simple, albeit course, measure of available habitat. It takes into account the channel length within a basin (channel density) and the habitat potential of those channels (via the intrinsic potential index). It can be used to rank basins in terms of potential habitat availability as discerned from these simple, topographically based criteria.

The potential effects of wood are incorporated into the index by the proportion of estimated wood recruitment relative to a potential maximum recruitment rate. This maximum rate is calculated for all forested areas in mature and structurally complex stands. This proportion, calculated for each reach, varies between zero and one. This proportion is related to effects on habitat based on the role of wood in creating pools. Although this is not the only function served by woody debris, it is an important one for which data exists from which to infer effects of wood on one aspect of habitat.

Pool spacing varies inversely with the number of pieces of large wood found in a channel (Montgomery et al. 1995, Beechie and Sibley 1997). Beechie and Sibley (1997), using data from northwest Washington, report a relationship between mean pool spacing, the number of pieces of wood per unit channel length, and channel gradient:

pool spacing (pools per channel width) = 2.7 - 4.6(slope x LWD/m) + 1.6(slope)

A minimum spacing of two pools per channel width occurred at a wood loading of 0.4 pieces per meter. Higher wood loadings did not result in smaller pool spacing. The assumption is that the maximum potential wood recruitment rate, obtained when all forested areas are in mature and structurally complex stands, results in this minimum spacing, which corresponds to the maximum number of pools. The maximum pool spacing, corresponding to the minimum number of pools, occurs when there is no wood. These endpoints, a minimum spacing of two pools per channel width and a maximum given by 2.7 + 1.6(slope) provide the potential range in the number of pools within a reach. This equation implies that the proportional change in the number of pools in a reach between full wood loading and no wood loading is:

Pmin = 2/(2.7+1.6*slope). Where: pmin is the proportion of the maximum number of pools expected in a reach; the maximum occurs when the reach is fully loaded with wood, the minimum (Pmin) occurs when there is no wood.

At zero slope this ratio is 74%; for a 5% channel, the ratio is approximately 19%. The ratio is an index of wood recruitment. If wood recruitment for a reach is equal to that calculated for a uniform mature and structurally complex forest cover (the maximum value), the index value is one. If recruitment is zero, the index value is given by Pmin. The index value for recruitment rates between the maximum and zero varies linearly from one to Pmin based on the proportion of the maximum recruitment rate. Potential habitat availability for each reach is then multiplied by the resulting wood index value. As wood recruitment rate goes to zero, the potential habitat availability is reduced by Pmin.